AL.2.2005-85
c.2

Report **2004-A**

Alberta Single-Well Gas Pool Drainage Area Study

December 2004

Alberta Energy and Utilities Board

Acknowledgements

The following EUB staff contributed to this report:
Author: Nehru Ramdin; Technical work: Dejan Andjelic, Andy Burrowes, Nehru Ramdin; Editors: Andy Burrowes, Joe MacGillivray; and Production: Ona Stonkus, Anne Moran.

ALBERTA ENERGY AND UTILITIES BOARD
Report 2004-A: Alberta Single-Well Gas Pool Drainage Area Study

December 2004

Published by
Alberta Energy and Utilities Board
640 – 5 Avenue SW
Calgary, Alberta
T2P 3G4

Telephone: (403) 297-8311
Fax: (403) 297-7040
Web site: www.eub.gov.ab.ca

Contents

Background 1
Procedure 1
Study Results 3
Revised Drainage Area 3
Geological Distribution 5
Revision of Additional Pools 6
Conclusions 7
Appendix SWGP Study Revised Drainage Areas by Formation 10

Digitized by the Internet Archive
in 2015

https://archive.org/details/albertasinglewel00ramd

Alberta Single-Well Gas Pool Drainage Area Study

The energy industry, lending institutions, and governments base important decisions on reserve estimates. Since drainage area is a major component in the volumetric determination of reserves for single-well pools, the accuracy of the area being assigned is critical. This study reviewed the drainage areas of single-well gas pools to determine the most appropriate drainage areas by geological strata. The new drainage areas have been adopted by the Alberta Energy and Utilities Board (EUB) and used in the setting of reserves for single-well pools.

Background

The EUB estimates reserves on a pool-by-pool basis. Initially reserves are determined volumetrically, with all parameters measured, except for drainage area and recovery factor, which are estimated. Pools are classified as isopached (contoured net pay map), single-well assignment (single-well pool with assigned drainage area), or joint assignment (two or more wells pooled together with assigned drainage area). The drainage areas for single-well gas pools have been based on a study completed in 1990 entitled "Alberta's Small Gas Pool Reserves Study,"[*] also known as the "Small Gas Pool Study" (SGPS). That study reviewed the performance of 2668 single-well pools, producing from a number of geological formations throughout the province. The number of pools was limited because most of the single-well gas pools in the province at the time were shut in due to lack of demand, low gas prices, and lack of infrastructure.

The SGPS found that the volumetric reserves for single-well pools were overstated by about 25 per cent and resulted in the revision of drainage areas from the conventional 200 hectares (ha) for all formations to 100, 150, 200, or 250 ha, depending on the specific geological formation.

Since the SGPS in 1990 there has been a marked increase in the number of producing single-well pools as shut-in pools and newly discovered single-well pools are placed on production. In 2002, the EUB initiated the "Alberta Single-Well Gas Pool Drainage Area" (SWGP) study to determine if the existing SGPS drainage areas were still appropriate, given the large inventory of single-well pools.

Procedure

In 2002, Alberta had reserves booked for 31 482 gas pools. Among these were 18 379 single-well pools, of which the SWGP study analyzed 7000. The remaining 11 379 pools were eliminated from the study because they were associated with oil pools, had little or no production, or were commingled. Pools that had drainage areas of less than 1 ha or more than 500 ha, based on reserves assessment by production decline, were also eliminated. The 7000 pools analyzed were nonassociated single-well gas pools that were distributed throughout the province in a wide variety of geological formations. Of these, 3000 had enough production for their producible reserves to be evaluated by production decline. The remaining 4000 had their producible reserves set to equal their production because they were abandoned, shut in, or had not produced for the last three years. Based on the producible reserves derived from pool performance, the estimated drainage areas for these 7000 pools were back-calculated using their existing pool recovery factor. The recovery factor, which is the ratio of producible gas to gas-in-place, is initially set using a formula described in a 1965 study by Stoian and Telford.* The formula estimates abandonment pressure based on depth. The abandonment pressure is adjusted for factors such as field compression, presence of gas/water interface, and well deliverability in order to obtain the pool recovery factor. The recovery factors obtained using this formula range between 50 and 85 per cent.

---

[*] Warren, A., "Alberta's Small Gas Pool Reserves Study," *Journal of Canadian Petroleum Technology*, Vol. 29, No. 4 (July-August 1990), pp. 34-40.

These new drainage areas were plotted, revealing a Pareto-type distribution, as shown in Figure 1, in which the first group represents the mode and contains pools with the smallest areas. The distribution had a median of 63 ha and a mean of 113 ha, which indicated that the SGPS drainage areas of 100 to 250 ha were too large and should be reviewed. This Pareto-type distribution was also exhibited in other plots in the study, and the median for each plot was used in determining drainage areas. The median was used because it is thought to be more conservative and reflects that the size of newly discovered single-well pools is expected to decrease over time. This is illustrated in Figure 2, which represents the province's natural gas pool size by discovery year since 1965. The median has remained fairly constant and consistently less than the mean, which has declined significantly over time, pointing to smaller pool size in the future.

Since drainage areas are assigned to pools based on formation, the 7000 pools were grouped by formations and the median was derived for each formation. In order to obtain a larger sampling and more meaningful distribution, formations with similar medians were grouped into four categories, as shown in Table 1. The pools in each category were plotted and a median was derived for each category. The value of this median was deemed to represent the drainage area for pools in the formations within that category.

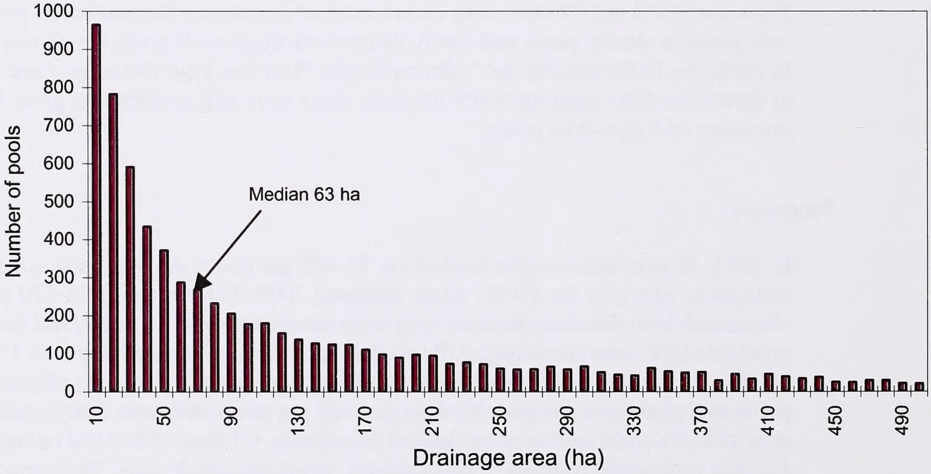

Figure 1: Distribution of all single-well gas pools grouped by drainage area

---

* Stoian, E., and Telford, A. S., Determination of Natural Gas Recovery Factors; *Journal of Canadian Petroleum Technology,* Vol. 5, No.3 (July – Sept. 1966), pp. 152-129.

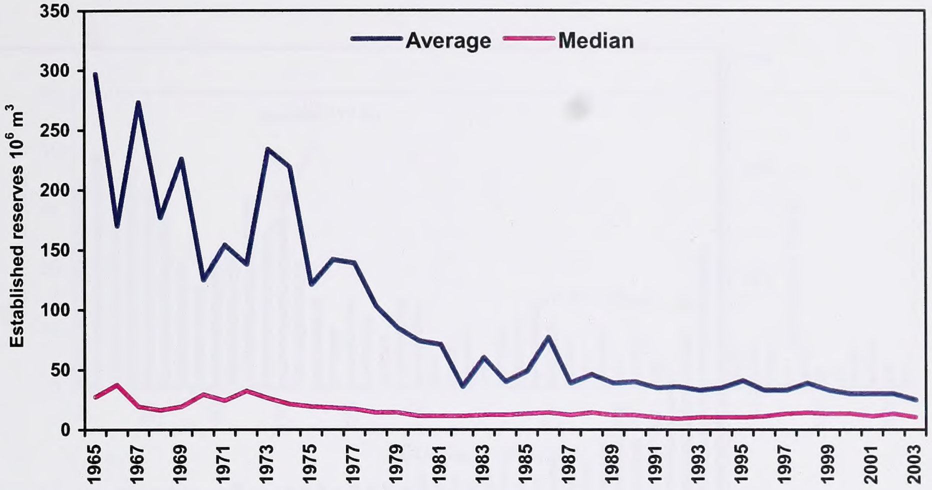

Figure 2. Gas pools size by discovery year

Study Results

Revised Drainage Area

Table 1 also shows the new drainage areas assigned for all formations within each category. These new areas were based on the median derived from each category and adjusted to reflect the closest standard drilling spacing units as established by the EUB.

Table 1. Drainage areas by category

Category	Median range (ha)	# of pools	Median (ha)	New area (ha)
1	1 – 50	1634	33	32
2	51 – 100	4532	66	64
3	101 – 150	687	117	128
4	>150	147	194	200

Category 1 had 1634 pools, 48 per cent of which were within the Cretaceous Ellerslie Formation. The drainage area for the Ellerslie was reduced to 32 ha from 150 ha. Category 2 had 4532 pools, with 50 per cent in Cretaceous formations from the base of the Glauconitic to the top of the Mannville. The drainage areas of these formations were reduced to 64 ha from 150 ha. Category 3 had 65 per cent of its 687 pools in the Belly River Formation, which had its drainage area reduced to 128 ha from 250 ha. Category 4 had 61 per cent of its 147 pools in the Bluesky Formation. Their drainage areas remained unchanged at 200 ha.

The distribution of pools within each of the four categories is presented in Figures 3 through 6. Note that the vertical axis scales, indicating number of pools, varies significantly from graph to graph. The area distribution of all plots, with the exception of category 4, shows a Pareto-type distribution. Category 4 displays a more random distribution because of its much smaller sample size of only 145 pools. However, the potential error in assigning an area to these pools is mitigated by the fact few pools are likely to be discovered in these formations.

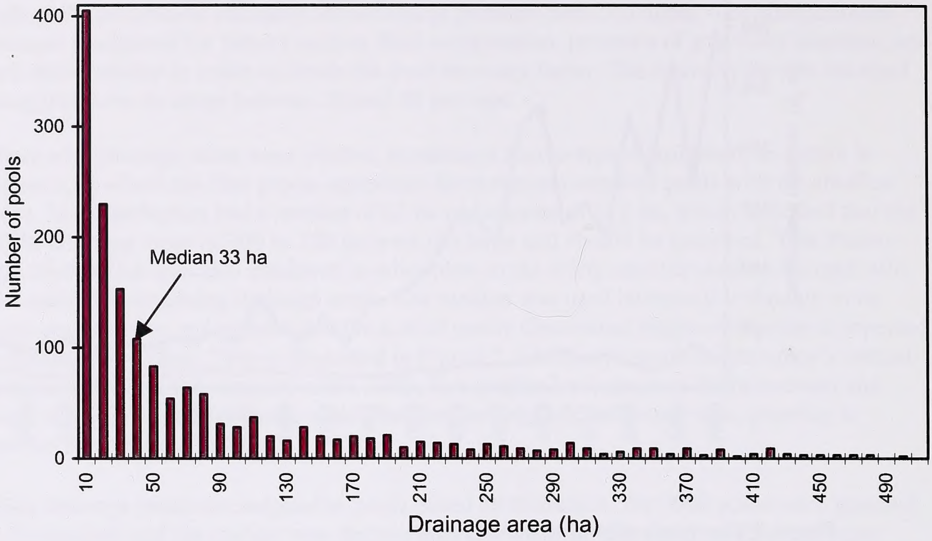

Figure 3. Drainage area distribution for category 1 pools (< 51 ha)

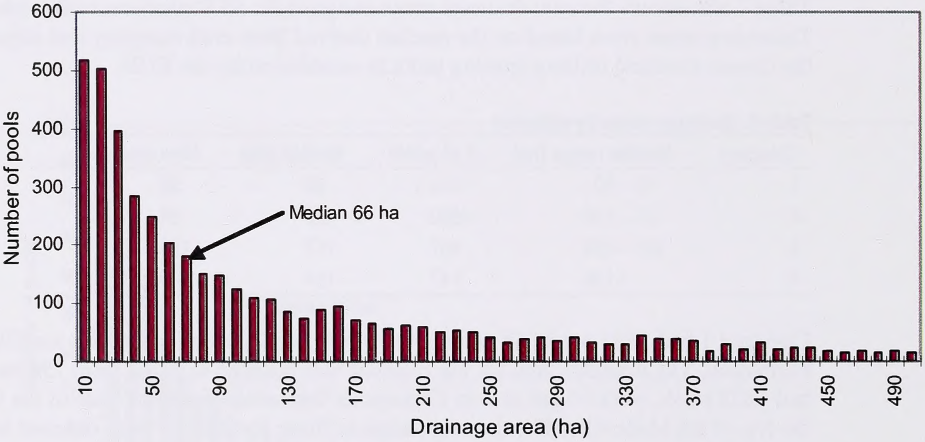

Figure 4. Drainage area distribution for category 2 pools (51-100 ha)

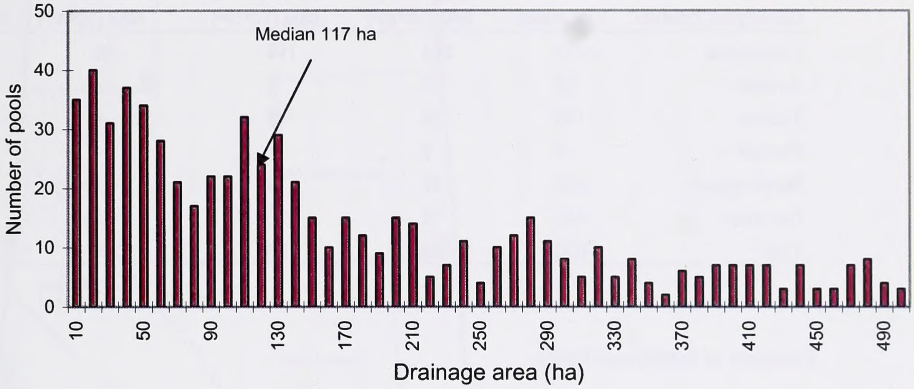

Figure 5. Drainage area distribution for category 3 pools (101-150 ha)

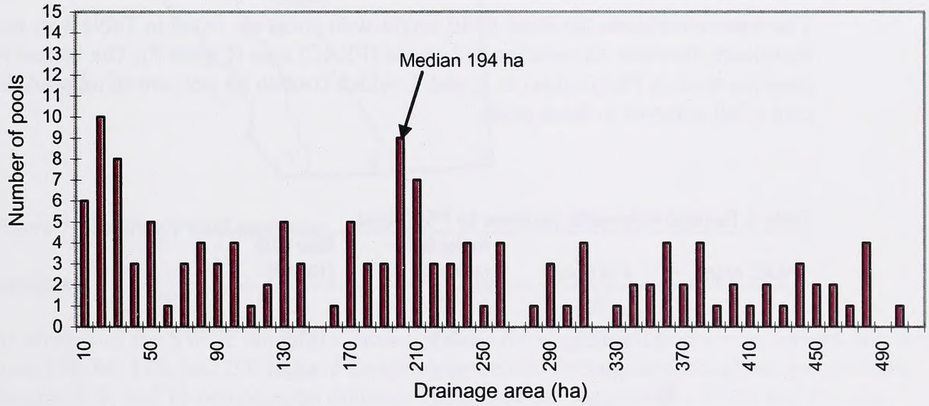

Figure 6. Drainage area distribution for category 4 pools (>150 ha)

Geological Distribution

The SWGP study included pools from different formations and zones throughout Alberta. The distribution of all 7000 pools by geological interval, the number of pools in each interval, and the initial marketable gas (IMG) volumes estimated by both volumetrics and performance is summarized in Table 2. Reserves estimated by performance were substantially less than those estimated by volumetrics, indicating that drainage areas based on the SGPS were too large. For example, the Cretaceous interval, which contains 86 per cent of the pools, had reserves reduced by 56 per cent based on pool production performance.

Table 2. Geological breakdown of pools

Geological interval	# of pools	Volumetrics IMG (10^9 m^3)	Performance IMG (10^9 m^3)	Change in IMG (10^9 m^3)	Total change (%)
Cretaceous	6051	204	114	-90	-56.3
Jurassic	88	8	4	-4	-2.5
Triassic	103	10	4	-6	-3.8
Permian	13	2	1	-1	-0.1
Mississippian	258	37	16	-20	-13.1
Devonian	487	58	20	-38	-23.8
Total	7000	319	158	-160	100.0

Revision of Additional Pools

The drainage areas of an additional 6940 single-well pools, which had little or no production and were booked volumetrically, were changed to the SWGP drainage area. This adjustment resulted in a reserves reduction of 211 billion cubic metres (10^9 m^3), or 70 per cent of the original volumetric reserves of 301 10^9 m^3.

The reserve revisions for these 6940 single-well pools are listed in Table 3 by modified Petroleum Services Association of Canada (PSAC) area (Figure 7). The largest reductions in reserves were in PSAC areas 2, 3, and 5, which contain 83 per cent of all pools and 88 per cent of all reserves in these pools.

Table 3. Revised volumetric reserves by PSAC area

PSAC area	# of pools	Initial IMG (10^9 m^3)	New IMG (10^9 m^3)
1	70	8.7	2.3
2	2180	147.7	37.9
3	1611	51.6	18.9
4	530	10.9	4.4
5	1961	66.0	21.0
6	322	5.1	2.5
7	240	9.6	2.7
8	26	1.4	0.3
Total	6940	301.0	90.0

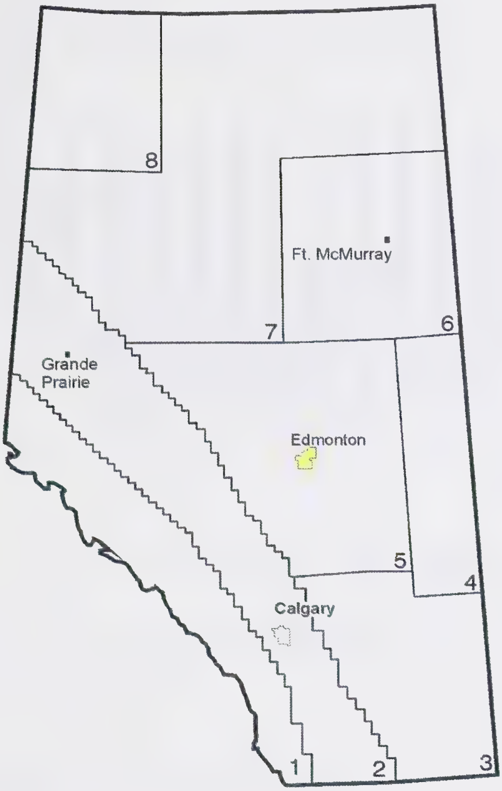

Figure 7. Modified PSAC area map

Conclusions

As a result of the SWGP study, the drainage areas for single-well pools were revised into four sizes (32, 64, 128, and 200 ha) and assigned to specific formations throughout the province. Figures 8, 9, and 10 compare the drainage areas between the previous SGPS and the new SWGP study. All the producing zones are listed in the appendix in alphabetical order with the revised drainage areas that will be assigned initially by the EUB to all new single-well pools for the determination of reserves.

Based on this study, the overall reduction in estimated reserves is about 70 per cent. This will result in the EUB's estimate of reserve growth being lower for new gas pools in the province. Cretaceous formations had the largest reductions in drainage areas, from the previous size of 150 ha or greater to the new sizes of 32, 64, or 128 ha. The reduced drainage areas for single-well pools reflect the maturing stage of the Western Canadian Sedimentary Basin and the fact that smaller pools that previously may have been abandoned can now be produced economically because of higher prices and easy access to infrastructure. Also, smaller pools can now be detected through improved seismic technology.

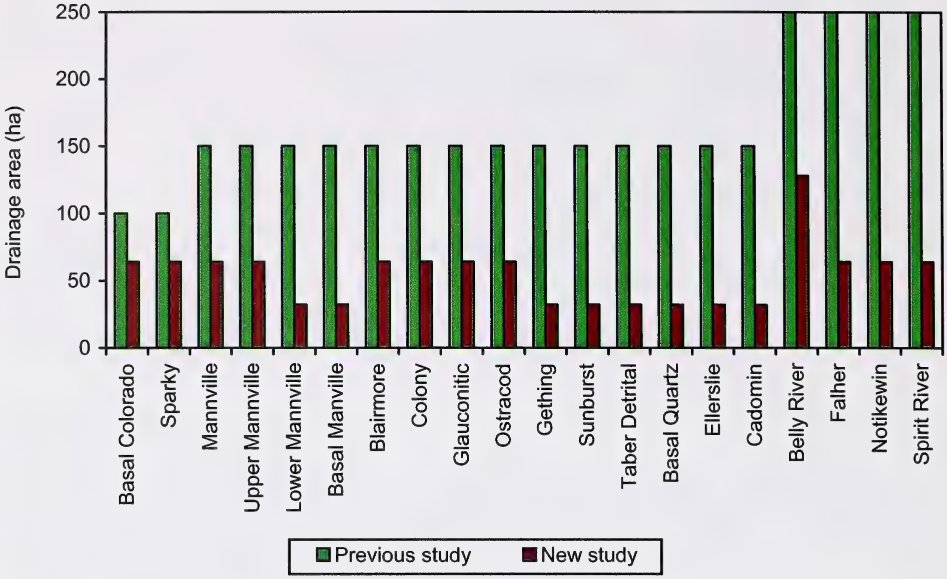

Figure 8. Comparison of previous and new study drainage areas

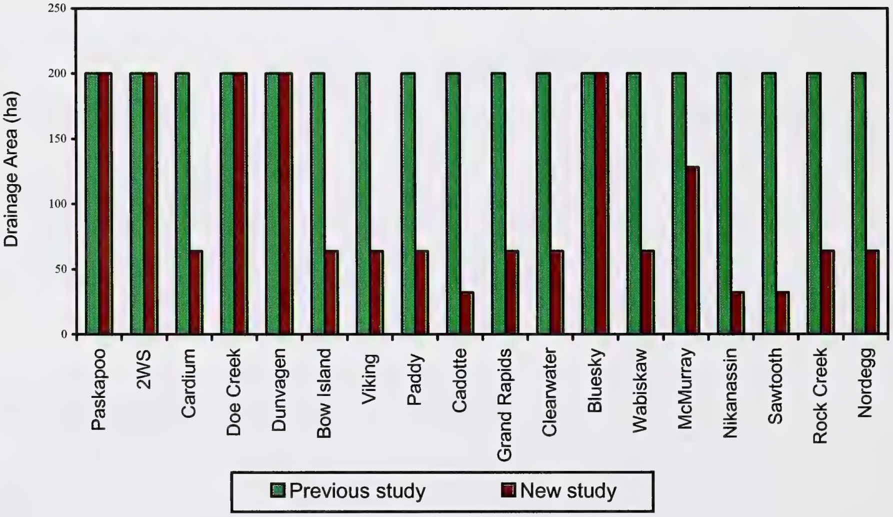

Figure 9. Comparison of previous and new study drainage areas

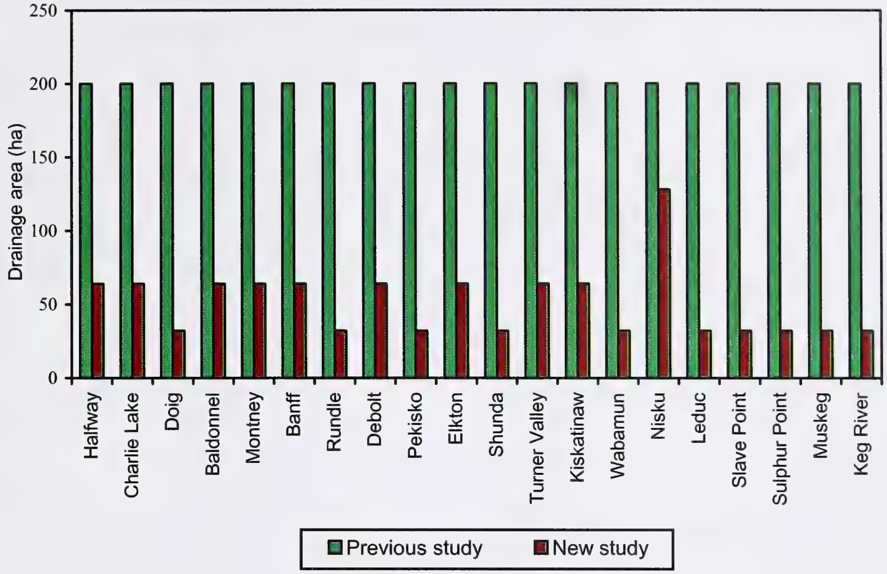

Figure 10. Comparison of previous and new study drainage areas

Appendix SWGP Study Revised Drainage Areas by Formation

Formation Name	New Area (ha)
ALEXO FM	32
ARCS MBR	32
ARCS-GROTTO	32
BADHEART FM	128
BAKKEN FM	64
BALDONNEL FM	64
BANFF FM	64
BARONS SD	200
BASAL BELLY RIVER SD	128
BASAL BLAIRMORE	32
BASAL COLORADO SD	64
BASAL GETHING	32
BASAL MANNVILLE	32
BASAL QUARTZ SD	32
BASAL RED BEDS	32
BASAL REEF	128
BASE FISH SCALES ZONE	200
BEARPAW FM	128
BEAVERHILL LAKE GRP	128
BELEMNITE ZONE	32
BELLOY FM	32
BELLY RIVER GRP	128
BIG VALLEY FM	32
BLAIRMORE GRP	64
BLSK-GETH-MONT	200
BLUERIDGE MBR	32
BLUESKY FM	200
BLUESKY-BULLHEAD	200
BLUESKY-DEBOLT	64
BLUESKY-GETHING	200
BLUESKY-MONTNEY	200
BLUESKY-TRIASSIC	200
BOUNDARY MBR	64
BOW ISLAND SD	64
BRAZEAU FM	128
BROSSEAU MBR	128
BROWN SD	32
BULLHEAD GRP	32
CADOMIN FM	32
CADOTTE MBR	32
CAIRN FM	128
CALUMET MBR	128
CAMROSE	200
CAMROSE TONGUE	200
CARDIUM CGL	64
CARDIUM FM	64
CARDIUM SD	64
CHARLIE LAKE FM	64
CHINOOK MBR	64
CHRISTINA MBR	128
CLEARWATER FM	64
CLEARWATER SD	64
COALSPUR FM	200
COLONY MBR	64
COLORADO GRP	128
COOKING LAKE FM	128
CROSSFIELD MBR	32
CROWFOOT FM	32
CUMMINGS MBR	64
CUTBANK SS	32
DAIBER GRP	64
DALHOUSIE CGL	32
DEBOLT FM	64
DEBOLT-DETRITAL	64
DETRITAL	32
DETRITAL-LIVINGSTONE	64
DETRITAL-NISKU	32
DETRITAL-WABAMUN	32
DINA MBR	32
DOE CREEK MBR	200
DOIG FM	32
DRIFT UNDIFFERENTIATED	200
DUNVEGAN FM	200
DUVERNAY FM	128
EDMONTON GRP	200
ELKTON MBR	64
ELKTON-SHUNDA	32
ELLERSLIE MBR	32
ELLERSLIE-WABAMUN	32
ELLIS GRP	32
FALHER A	64
FALHER B	64
FALHER C	64
FALHER D	64
FALHER E	64
FALHER F	64
FALHER MBR	64
FIRST WHITE SPECKS	128
FISH SCALE SD	200
FOREMOST FM	128
GENERAL PETROLEUM MBR	64
GETHING FM	32
GILWOOD MBR	64
GLAUCONITIC SS	64
GRAMINIA FM	32
GRAND CACHE MBR	64
GRAND RAPIDS FM	64
GRANITE WASH	32
GRAVELBOURG	32
GROSMONT FM	200
HALFWAY FM	64
HAMILTON LAKE MBR	128
HOME SD	64
HORSESHOE CANYON FM	128
IRETON FM	128
ISLAY MBR	64
JEAN MARIE FM	32
JEFFERSON FM	32
JUDITH RIVER FM	128
JUMPING POUND MBR SS	200
JURASSIC DETRITAL	64
JURASSIC SS	64
JURASSIC SYSTEM	64
KEG RIVER FM	32
KEG RIVER SS	32
KISKATINAW FM	64
KOOTENAY GRP	32
LABICHE FM	128

Formation Name	New Area (ha)
LEA PARK FM	128
LEDUC FM	32
LIVINGSTONE FM	32
LLOYDMINSTER MBR	64
LOOMIS MBR	64
LOWER BANFF	64
LOWER BLAIRMORE	32
LOWER COLORADO SAND	128
LOWER DEBOLT	64
LOWER GRAND RAPIDS	64
LOWER KEG RIVER	32
LOWER MANNVILLE FM	32
LOWER VIKING	64
LUSCAR FM	64
MANNVILLE GRP	64
MCLAREN MBR	64
MCMURRAY FM	128
MCMURRAY-GROSMONT	128
MEDICINE HAT SD	128
MIDDLE BANFF	64
MIDDLE GRAND RAPIDS	64
MIDDLE VIKING	64
MILK RIVER FM	64
MIST MOUNTAIN FM	32
MOBERLY MBR	128
MONTNEY FM	64
MORRISSEY FM	32
MORRO MBR	32
MOULTON SD	200
MOUNT HEAD FM	64
MOUNTAIN PARK FM	64
MUSKEG FM	32
NIKANASSIN FM	32
NISKU FM	128
NORDEGG MBR	64
NORDEGG-BANFF	64
NORDEGG-DETRITAL	64
NOTIKEWIN MBR	64
OLDMAN FM	128
OSTRACOD SS	64
PADDY MBR	64
PADDY-CADOTTE	64
PAKOWKI	128
PALLISER FM	32
PASKAPOO FM	200
PEACE RIVER FM	64
PEECHEE MBR	128
PEKISKO FM	32
PELICAN FM	64
PERMO-PENN SYSTEM	32
PINE POINT FM	32
PROVOST MBR	200
QUATERNARY SYSTEM	200
REX MBR	64

Formation Name	New Area (ha)
RIBSTONE CREEK MBR	128
ROCK CREEK MBR	64
RUNDLE GRP	32
SAWTOOTH FM	32
SECOND WHITE SPECKS	200
SHAFTESBURY FM	200
SHAUNAVON FM	32
SHUNDA FM	32
SHUNDA-PEKISKO	32
SLAVE POINT FM - above TWP 99	64
SLAVE POINT FM - below TWP100	32
SLAVE PT-GRAN WASH	32
SOUTHESK FM	32
SPARKY MBR	64
SPIRIT RIVER FM	64
SPRAY RIVER GRP	64
ST. EDOUARD MBR	64
ST. MARY RIVER FM	200
STETTLER FM	32
STODDART GRP	64
SULPHUR POINT FM	32
SUNBURST SD	32
SUNBURST-SWIFT	32
SWAN HILLS MBR	128
SWIFT FM	32
TABER–DETRITAL	32
TABER SD	32
TAYLOR FLAT FM	64
TRIASSIC SYSTEM	64
TURNER VALLEY FM	64
UPPER BANFF	64
UPPER BLAIRMORE	64
UPPER DEBOLT	64
UPPER GRAND RAPIDS	64
UPPER IRETON	128
UPPER MANNVILLE FM	64
UPPER VIKING	64
VICTORIA MBR	128
VIKING FM	64
VIKING SANDSTONE	64
VIKING-BLAIRMORE	64
WABAMUN GRP	32
WABAMUN-GRAMINIA	32
WABISKAW MBR	64
WABISKAW SS	64
WABISKAW-MCMURRAY	32
WAINWRIGHT SD	64
WAPIABI FM	64
WAPITI GRP	128
WASECA MBR	64
WINNIPEGOSIS FM	32
WINTERBURN GRP	32
WOODBEND GRP	128
ZAMA & KEG RIVER	32
ZAMA MBR	32

NATIONAL LIBRARY OF CANADA
Bibliothèque nationale du Canada
3 3286 53031538 7